Reconstruction of Historical Air Pollutant Fallout using Lake Sediment Cores

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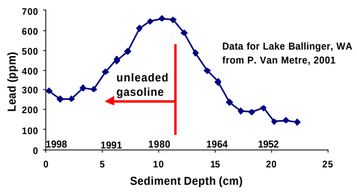
Abstract

Lake sediments are like a tape recorder of historical air pollutant fallout. Pollutants are deposited onto lake surfaces by wind-blown dust and direct (wet/dry) deposition where they are are trapped in annual accumulation of sediment layers (typically 0.05 to 10 mm/yr) on the bottom. By evaluating the concentration of a pollutant in the different layers and estimating the date the sediment layers were deposited, a time history of fallout may be reconstructed. In July 2001, we obtained sediment cores at Sandhole Lake, Camas National Wildlife Refuge, and Mud Lake, Idaho to reconstruct atmospheric mercury (Hg) fallout trends from pre-INEEL times to the present. Mercury (Hg) is a persistent, bioaccumulative, and toxic air pollutant that is believed to be sharply increasing in the atmosphere and terrestrial food-chains throughout the world. We obtained 9 cores (5-8 cm dia by 30-cm long) using a hand-coring device and sectioned the cores into 1-cm samples for measurements of mass accumulation rate, Hg, and Cesium-137 (Cs-137), the latter being used as a tracer to radiodate the layers. Initial Cs-137 results show a well-defined peak at 15-20 cm depth which suggests that our 30 cm cores may provide 50 years of record. Preliminary Hg results show increasing Hg concentrations with time. When the final Cs-137 results are received (est. Oct 2001), we will develop a time history of Hg fallout at these sites and attempt to correlate it with known natural and man-made Hg-emitting historical events.

Why Estimate Historical Trends?

- See if things are getting better or worse
- Evaluate the effectiveness of regulatory control measures



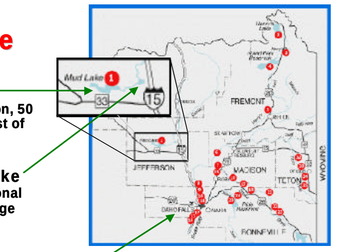
Objectives

- Where to sample? - lakes downwind of the INEEL that are undisturbed and have been water bodies for at least 40 years.
- How to sample? - methods to obtain undisturbed sediment cores in up to 10-ft water and section the cores into 1-cm samples.
- Analyze the samples for porosity (to est. dry mass accumulation), Cs-137, and Hg.
- Estimate the deposition dates of the samples using Cs-137 and dry mass accumulation rates.
- Compare the Hg fallout record with known historical events, both locally and regionally (e.g. volcanoes).
- Demonstrate the INEEL's commitment to environmental stewardship in the region.

Where

Mud Lake
- near Terreton, 50 km northwest of Idaho Falls
- 8-ft depth

Sandhole Lake
Camas National Wildlife Refuge
- near Hamer
- 3-ft depth



Idaho Falls

Why These Lakes?

- Downwind of the INEEL
- Sensitive wildlife species
- Both Lakes have been water bodies for at least 50 years, have never been known to completely dry up, and have few outlets and inlets that feed them (minor fluvial sedimentation)
- Hg has never been measured at these locations.

How

Sandhole Lake: 8-cm dia x 30-cm cores - wade, push butyrate plastic tube into the sediment, cap at top to create vacuum, extract core.

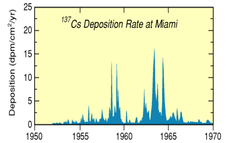
A plunger assembly was used to push the core out in 1- cm lengths which were sectioned and placed into sample bottles.

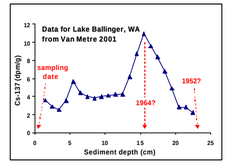
At Mud Lake: 5-cm cores - boat w/ Wildco® hand corer + 10-ft ext handle.

Radiodating with Cs-137

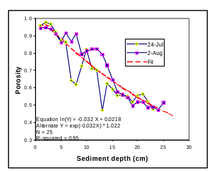
- Estimate the year each sediment layer was deposited
- Confirm sediment layers are undisturbed

Above-ground nuclear weapons testing (Nevada and South Pacific) produced worldwide global fallout
- first began around 1952
- biggest peak 1964





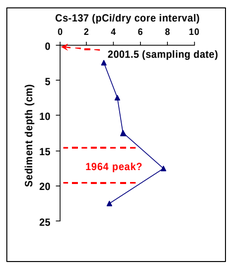
- Dates of sample layers between surface and 1964 Cs peak interpolated using sample interval dry mass accumulation (not length)
- Porosity (P) calculated for each 1-cm layer = fraction of water volume = mass of water/total sample volume
- Dry mass (DM) per 1-cm sample interval (g/cm^2) = (1-P)(2.5 g/cm^3)(1 cm)



Initial Cs-137 Results

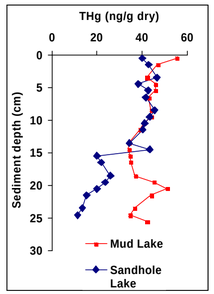
A "screening" analysis was initially done for 5-cm sample intervals at Sandhole Lake

A well-defined peak is present at 15-20 cm depth suggesting undisturbed sediment and approximately 50 - 60 years of record in a 30-cm core.



Initial Hg Results

Preliminary data:
- Increasing trend with time
- Sediment depths will be converted to fallout date when final Cs-137 lab results are received.
- Results may be normalized to sample percent organic matter to account for its higher relative absorption of Hg.



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